Space Weather Technical Forecast

Issued on Friday, 19 July 2024 at 13:07 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares Likely. G1 becoming Likely Saturday 20 July.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Moderate, with GOES16 registering a peak flare of M3.2 at 19/0823UTC from AR3753 in the northwest of the disc. There are now up to 18 sunspot regions on the disc, which is anecdotally a (roughly decade-spanning) record for this author, and the figure has been tentatively as high as 19 in the past 24 hours. This number included a number of magnetically simple high solar latitude regions, perhaps more akin to an early-cycle disc, although their sheer quantity was more like a solar maximum disc. None of these many regions showed reversed polarity compered with expectations for each hemisphere in the current cycle. Many of the main changes in the past 24 hours have occurred in the central portion of the disc near 10 South, with AR3751 showing areal growth and proliferation in its trailing spots, becoming a compact Zurich group. Also of note were AR3759 to its west, which also grew areally and showed a spreading tendency, while a third new unnumbered region developed from plage near 25 East. Other main regions perhaps included AR3753, 3745 and 3758, which all lie near 60 West, and all went through phases of proliferation of spots in the past day.

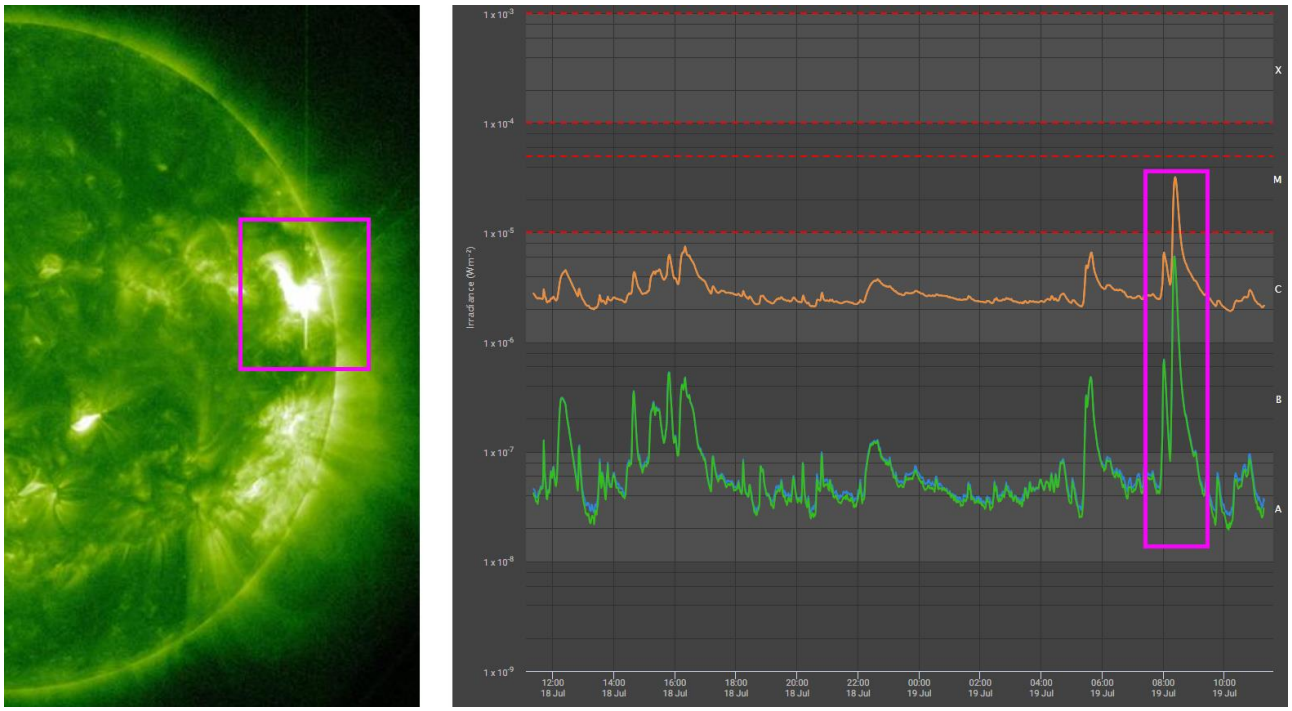

Figure 0: AIA094 and GOES16 X-ray trace for the peak event of the period: an M3.2 from AR3753 at 19/0823UTC

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No Earth-directed Coronal Mass Ejections (CMEs) have been observed in available imagery - a dimming following a south-central disc C3 flare around 18/2200UTC could not be tied to any obvious subsequent CME. A possible filament eruption occurred in the far northwest disc around 19/1100UTC - imagery for this event is awaited.

Solar Wind / Geomagnetic Activity: The solar wind speed, as measured by ACE at L1, was reflective of a slow regime: the solar wind speed fell from 350 to 300km/s before a late slight rally, the density was within long-term average values in single figures ppcc, and the IMF was at or below 6nT. The north-south component - Bz - showed gradual oscillation within this envelope between +4 and -3nT. The phi angle was initially away from the Sun (positive), but became negative between 19/0440UTC and 19/1000UTC.

The net result of the above solar wind measures was provisionally Quiet geomagnetic activity throughout, with a very slight peak in activity straddling the initial SSBC and phi angle change.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 remained at Background. High energy electron flux (greater than 2MeV) observed by GOES16 was at Normal Background levels. The 24-hour fluence was well below Active, with 1.01e6 integrated pfu observed at 19/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: M-class flares remain Likely through this period, with a Slight Chance of X-class. Several regions are due to arrive and depart in the four days, and although some volatility is therefore possible risks are held roughly constant for now.

Solar Wind /Geomagnetic Activity: Up to two CMEs feature in the forecast, with both emitted on 16 July and due at Earth very late in the current UTC day or more likely into Saturday 20 July. Active to G1/Minor Geomagnetic storms are Likely as a result. No significant fast winds otherwise feature, and the geomagnetic forecast should return to Quiet into the new UTC working week.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at Background levels, but with Slight Chance of rising above the S1/Minor Storm threshold in response to any notable flares. High energy electron flux is Expected to remain at Normal Background levels. The associated 24-hour fluence is Expected to remain well below the Active level, with reducing confidence owing to the inbound CMEs' effects.

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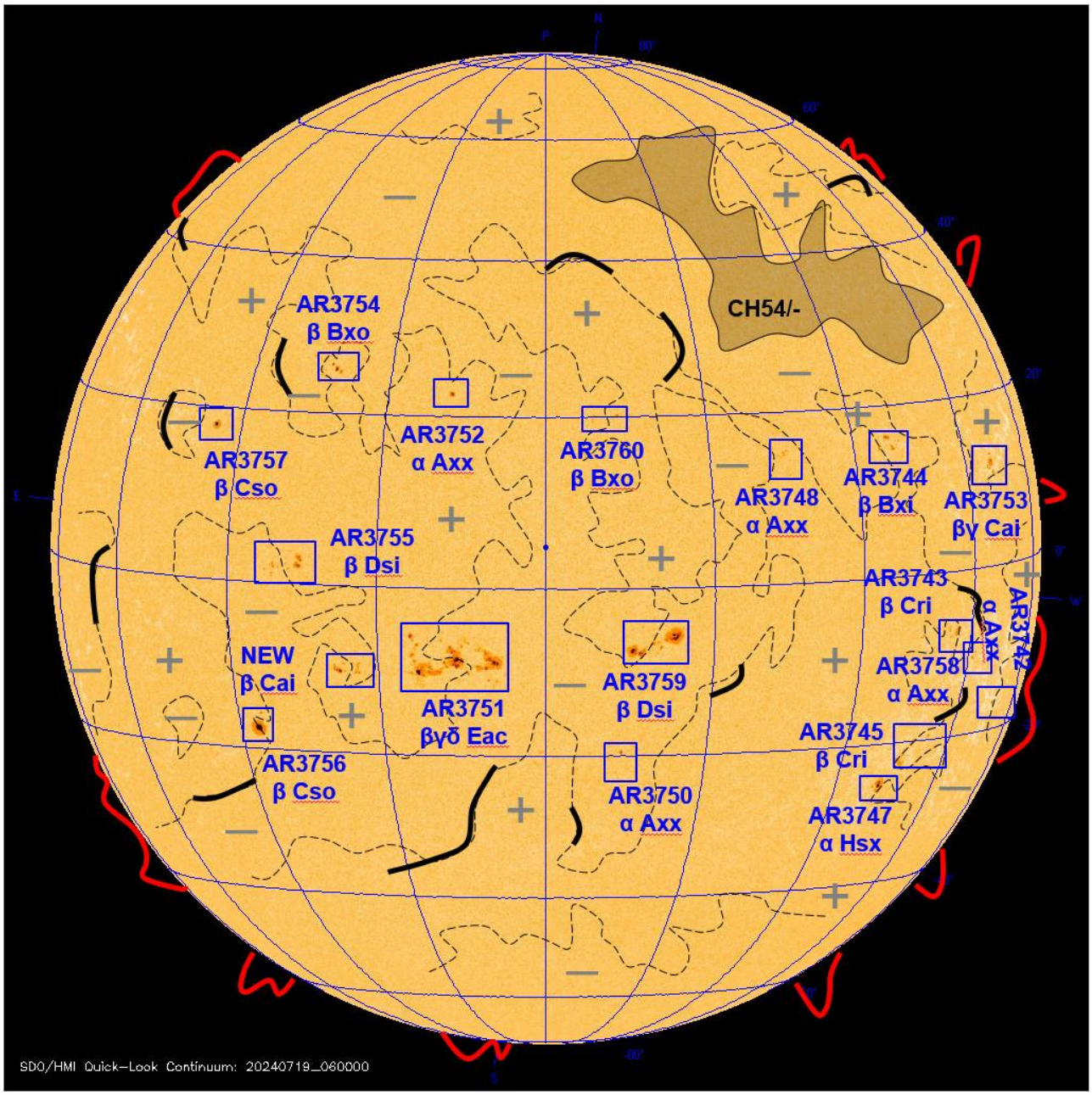
Figure 1. Solar Analysis Valid 19/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There are up to two CMEs that feature in the forecast, both emitted on 16 July. The posited sources were an M1.6 flare from AR3753 peaking at 16/2123 UTC in the northwest disc; and an M1.9 flare from AR3744 at 16/2206 UTC. A subsequent double CME was observed, although it appears likely these CMEs were both from the second of these flares, with a main material ejecta to the northeast. This was followed with a very weak asymmetric halo CME which is possibly mostly shock, but has not been discounted for some material content.

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The forecast otherwise comprises a probable slow regime throughout, however there remains a small chance of some influence from CH54/- at first in the four-day period, but probably now inconsequential for geomagnetic activity if present.

Confidence in the forecast is relatively low - both for the difficulties with analysis of the CMEs but also for the marginal influence of any initial fast wind. MOSWOC Enlil has shown a recent tendency to over-estimate initial solar wind speeds, and this is expected to affect the onset time of inbound features (arriving later than model expectations).

All considered the inbound CMEs are expected to arrive either at the very end of the current UTC day (Friday 19 July) or more likely on Saturday 20 July, although the second and slower of these CMEs may be imperceptible on arrival. Initial Quiet conditions are Likely to rise to peak at Active to G1/Minor Storm intervals into Saturday 20 July. Any CME effects should then gradually decrease later in the UTC weekend, with mainly Quiet conditions having returned by the new working week.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	60	20	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
17/0334	Nil	M1.9 AR3744	N-centre	691 km/s	19/2200 -6/+12 hrs	Likely combine with below CME.
17/0400	Asymmetric Halo	M1.9 AR3744	N-centre	530 km/s	19/2200 -6/+12 hrs.	Possibly mainly shock, but will combine with above.

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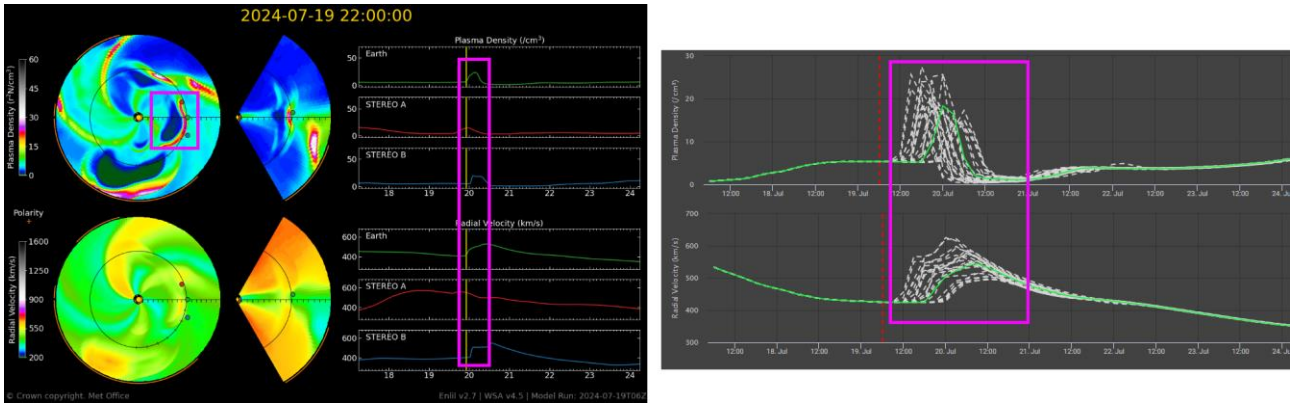
Figure 2: Latest MOSWOC Enlil model and ensemble (badge time 19/0600UTC), showing the 16 July CMEs boxed in magenta. Note that the initialised wind in MOSWOC Enlil is erroneously fast near 450km/s – with observations being nearer 300-350km/s, the early arrival part of the ensemble spread is currently not felt likely, with the simulation pasued around the deterministic arrival at 19/2200UTC, and the long-end soultions of the ensemble then offering a a more realistic spread.



Radio Blackouts - X-Ray Flares:

The current disc is populated by a large number of active regions, however this has necessarily partitioned the energy available to each. This has meant that there are relatively few large and complex regions on the current disc, with activity and complexity dominated by AR3751 in the southeast-central disc as an Eac/BGD. This region appears to overlie an area of development here, with its neighbours also growing in the past 24 hours, all while a second area of development has produced the peak flare activity near 60 West. Identifying trends in sunspots here is complicated by the narrowing viewing angle, however recent growth in regions such as AR3753 make this another area of interest.

Regarding the balance of sunspot regions in the period, AR3753 is due to leave the disc within the UTC day of Sunday 21 July, however most other potent sunspot regions should remain. The far side may see a steady series of arrivals into and over the UTC weekend, evidenced by recent helioseismograph imagery and returning Carrington locations for numerous regions. On balance the current daily risk of Likely M-class and a Slight Chance of X is felt to be reflective of expected conditions, but these figures may prove volatile within these bounds as new evidence emerges through this four-day forecast period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	10	10	10	10

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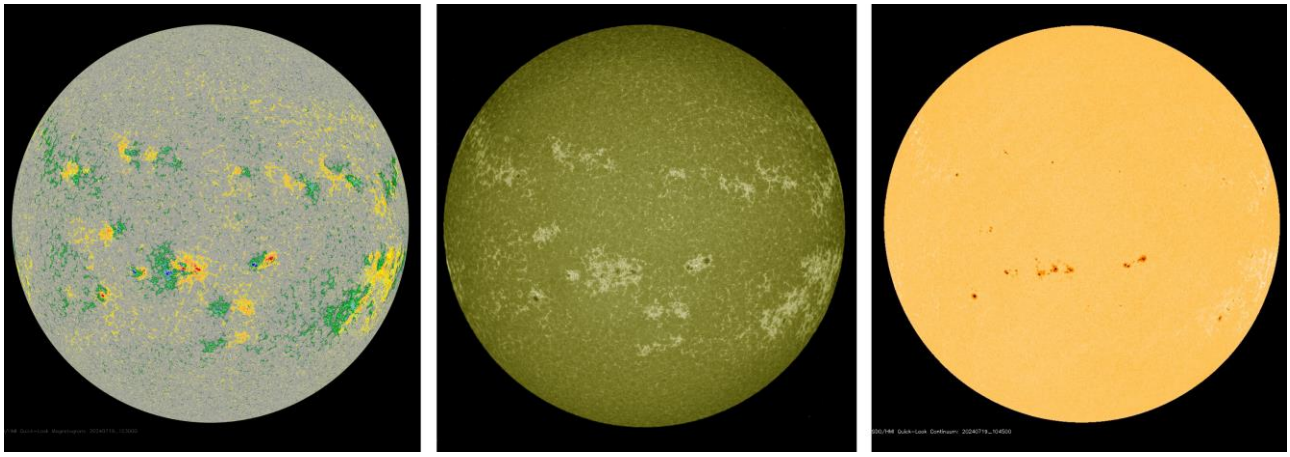
Figure 3: SDO suite of images from the hour of 19/1000UTC, respectively: HMIBC, AIA1600 and HMIIF, all showing the 'scattershot' solar disc at present.



Solar Radiation Storms - (High Energy Protons):

High energy proton flux at GOES18 is at Background and has shown no notable response at any level in relation to the past week's X-ray flares. The current UTC morning's M3.2 from AR3753 has yet to manifest on GOES18 traces, and it is now on the long end of registering (having happened several hours prior to issuing this document). This is the rationale for not increasing the day one probabilities by the residual 20% suggested from past events for western hemisphere M3 flares.

High energy proton flux is therefore most likely to remain at Background levels, but with a gradually rising Slight Chance of breaching the S1/Minor Storm threshold in response to any notable flares. Such flares are most likely from AR3751 and now AR3753, with both of these regions occupying the western hemisphere during the forecast period (with AR3753 crossing onto the far side over the UTC weekend), resulting in an overall slight increase in probabilities.

Radiation Storms	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ S1**	No	10	10	10	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

The high energy electron flux as observed by GOES16 is expected to remain at Normal Background levels. The main forecast driver for any deviation from this forecast is now not likely to occur to any significant degree (i.e CH54/- is relatively slow and subdued, as well as being of marginal influence if even present). In any case, increases in the flux are likely to quickly be suppressed by the expected increase in geomagnetic activity associated with the UTC weekend's CME arrivals.

The associated 24-hour electron fluence is expected to persist well below the Active level, albeit with reducing confidence into the new UTC working week. The latest MOSWOC REFM persists with its ideas of sub-Active fluence, although this is only a realistic signal prior to any CME influence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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